Applying the Design Structure Matrix (DSM) Technique to NASA Organizational Design

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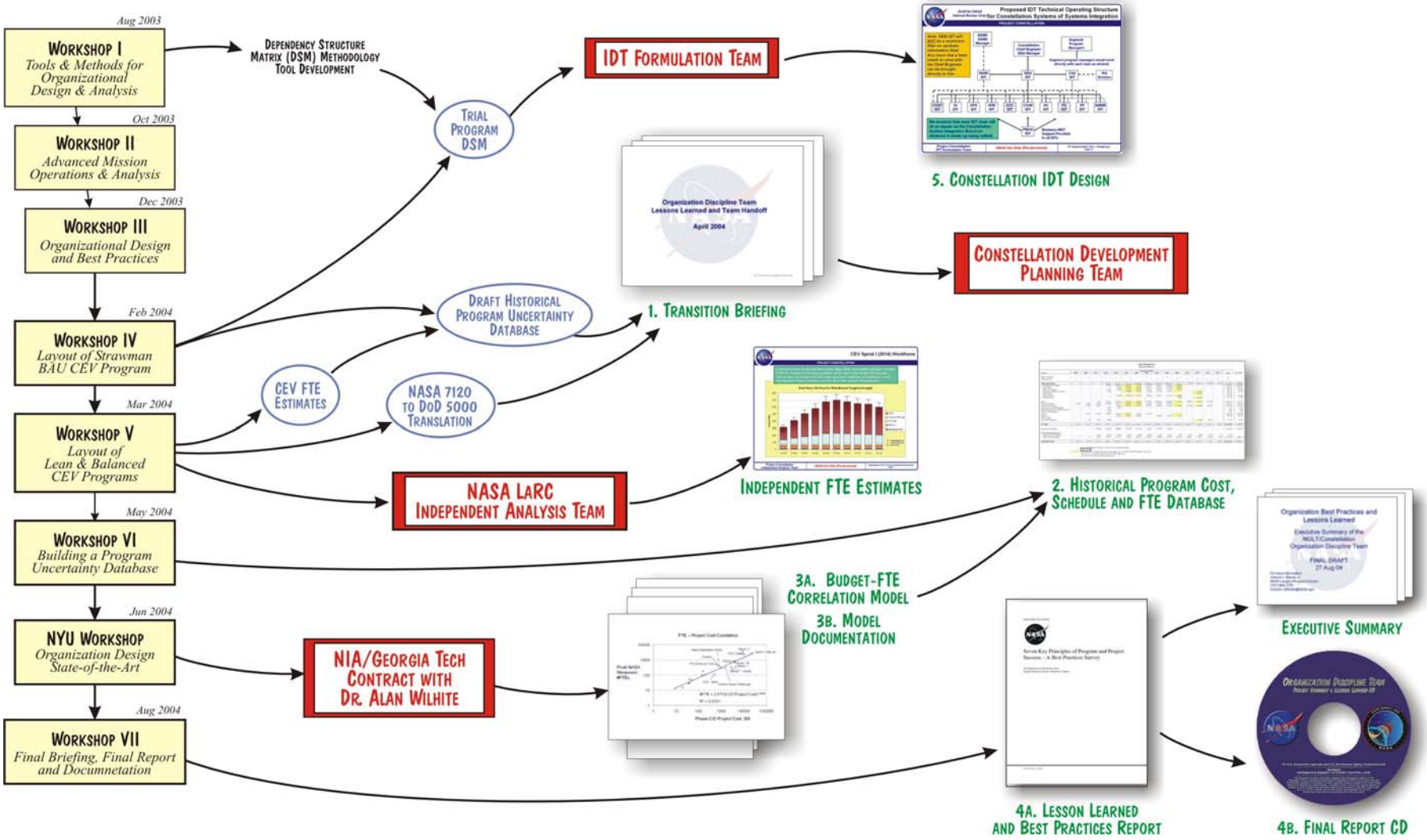
Objectives and Content

- **Objectives:**
  1. Introduce Design Structure Matrix (DSM) methodology
  2. Present a Practical Application of DSM in Organization Design

- **Content:**
  1. Background of the Organization Discipline Team
  2. Introduction to Design Structure Matrix Methodology
  3. Formulation of Integrated Discipline Teams (IDTs) for Constellation Systems

Background: Organization Discipline Team FY03-04 Activity

ORGANIZATION DISCIPLINE TEAM



Introduction to DSM

- **Uses of the Design Structure Matrix (DSM)**
  1. **Project Management Tool -** provides a project/organization representation that incorporates feedback and cyclic task dependencies.
  2. **System Analysis Tool –** provides a simple 2-d matrix to capture expert judgment for quantifying the dependence between organizational elements.

- **Advantages of DSM**
  1. Easy graphical representation of complex systems.
  2. Requires no special tools or algorithms, all modeling can be accomplished on a standard spreadsheet program such as MS Excel.

Source: *http://www.dsmweb.org/*

Types of System Analysis DSMs

- **Component-based DSMs**
  1. Documents interactions between elements in a complex system architecture.
  2. Types of component interactions (i.e. Spatial, Energy, Information, & Material).

- **Team-Based DSMs**
  1. Constructed by identifying required communication flows between organizational entities in the matrix.
  2. Types of information flow among teams (i.e. Level of detail, Frequency, Direction, Timing).

References:

1. *http://www.dsmweb.org/*

2. *"Framework for Evaluating Architecture, Technology and Organization Options", Tim Brady, NASA JSC, 14-Aug-2003.*

DSM Practical Application: Formulation of the Integrated Discipline Teams (IDTs) for Constellation Systems

IDT Formulation Study

ORGANIZATION DISCIPLINE TEAM

- **Organization Design Objectives:**
  1. Identify natural groupings of NASA workforce skills / competencies as a basis for team composition.
  2. Provide Constellation Systems with a team structure to harness and organize the effort of 190 FTE across the agency.

- **Approach:** Utilize the DSM to formulate an optimized IDT structure.

- **Required Team Members:** Two senior civil servants from each NASA center experienced in space system development.

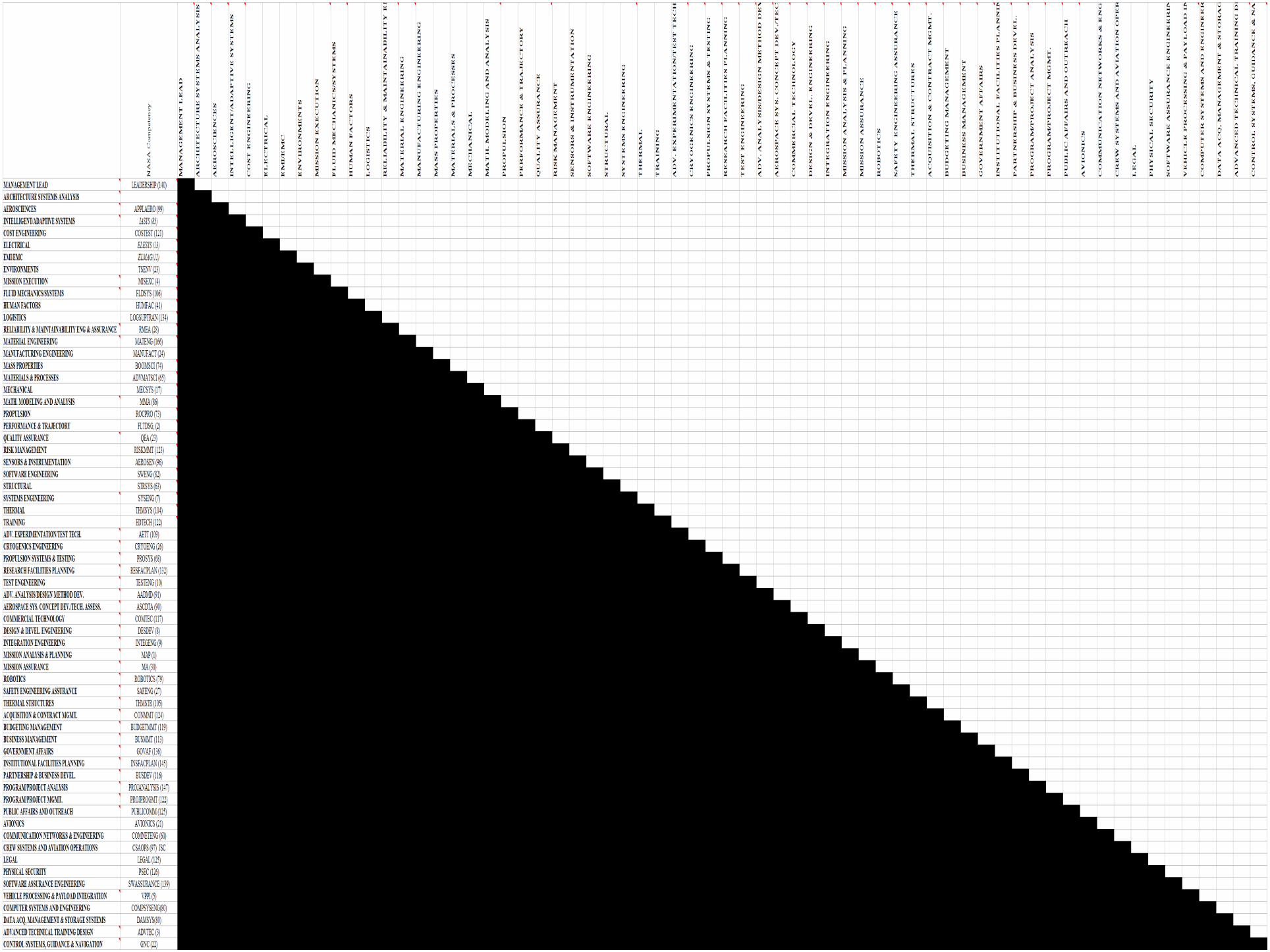
- **Study Period:** July to September 2004.

IDT Formulation Analysis Process

ORGANIZATION DISCIPLINE TEAM

1. **First rule of modeling: If you seek buy-in, the decision makers must be an integral part of the process.**
   a. Briefed all NASA center Points of Contact (POCs) on analysis methodology and requested study team representatives.
   b. Briefed methodology to team members by Webcast.

2. **Team members identified the workforce skills required to develop the Constellation Systems.**
   a. Skills Reference: NASA's standard Workforce Competency Dictionary (CMS-DOC-01).
   b. Skills placed alphabetically into a NxN matrix.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GNC (22)

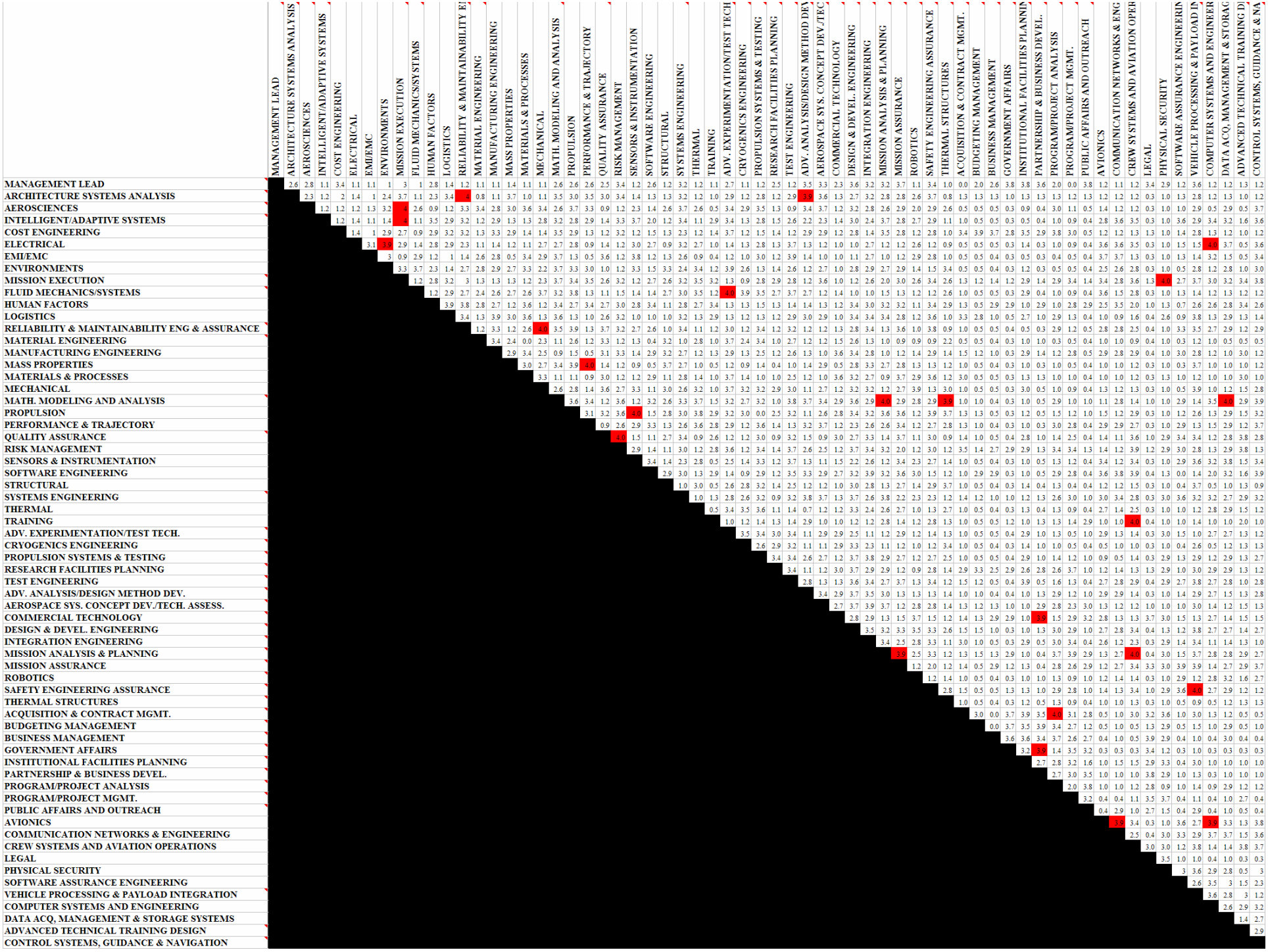
IDT Formulation Analysis Process

3. Team members assigned interaction values to Skills Matrix.

a. Input based on team member's experience and judgment.
b. All intersections required a value, even if it was a guess.
c. No rows or columns could be added, deleted, or moved.
d. Rate the level of interaction between every skill listed:
    1. High interaction = 9,
    2. Medium interaction = 3,
    3. Low interaction = 1,
    4. No interaction = 0.

4. A Standard Deviation Matrix was developed next.

a. Identified the input values that team members disagreed on the most.
b. A virtual consensus meeting was held to discuss those entries with the highest standard deviations.



IDT Formulation Analysis Process

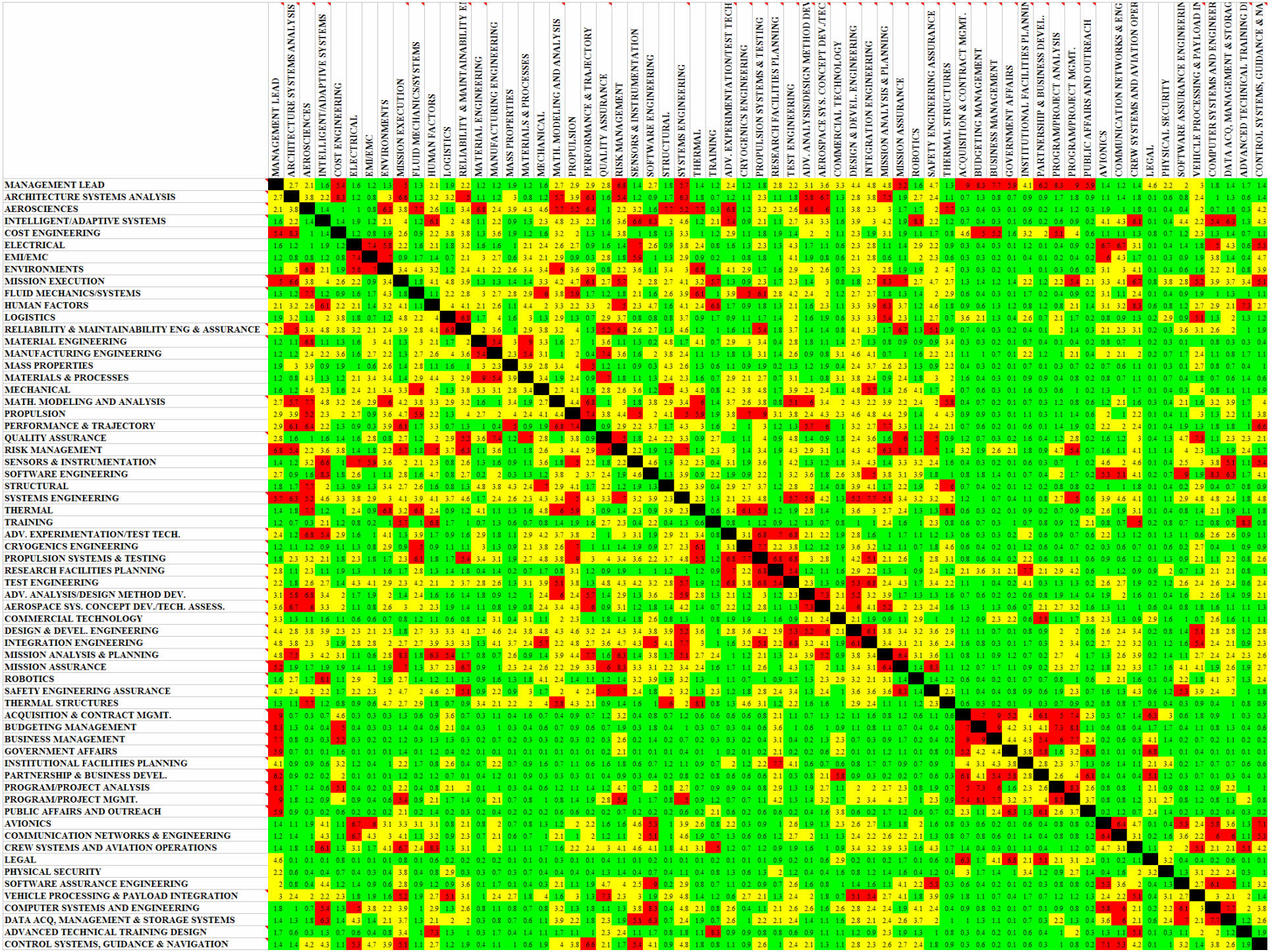
5. The Input Averages Matrix was developed next.

a. Averages of all the inputs were computed and integrated into one chart.

b. Matrix mirrored diagonally for clustering analysis.

c. Ranges set:

1. High Interaction = Red
2. Medium Interaction = Yellow
3. Low Interaction = Green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IDT Formulation Analysis Process

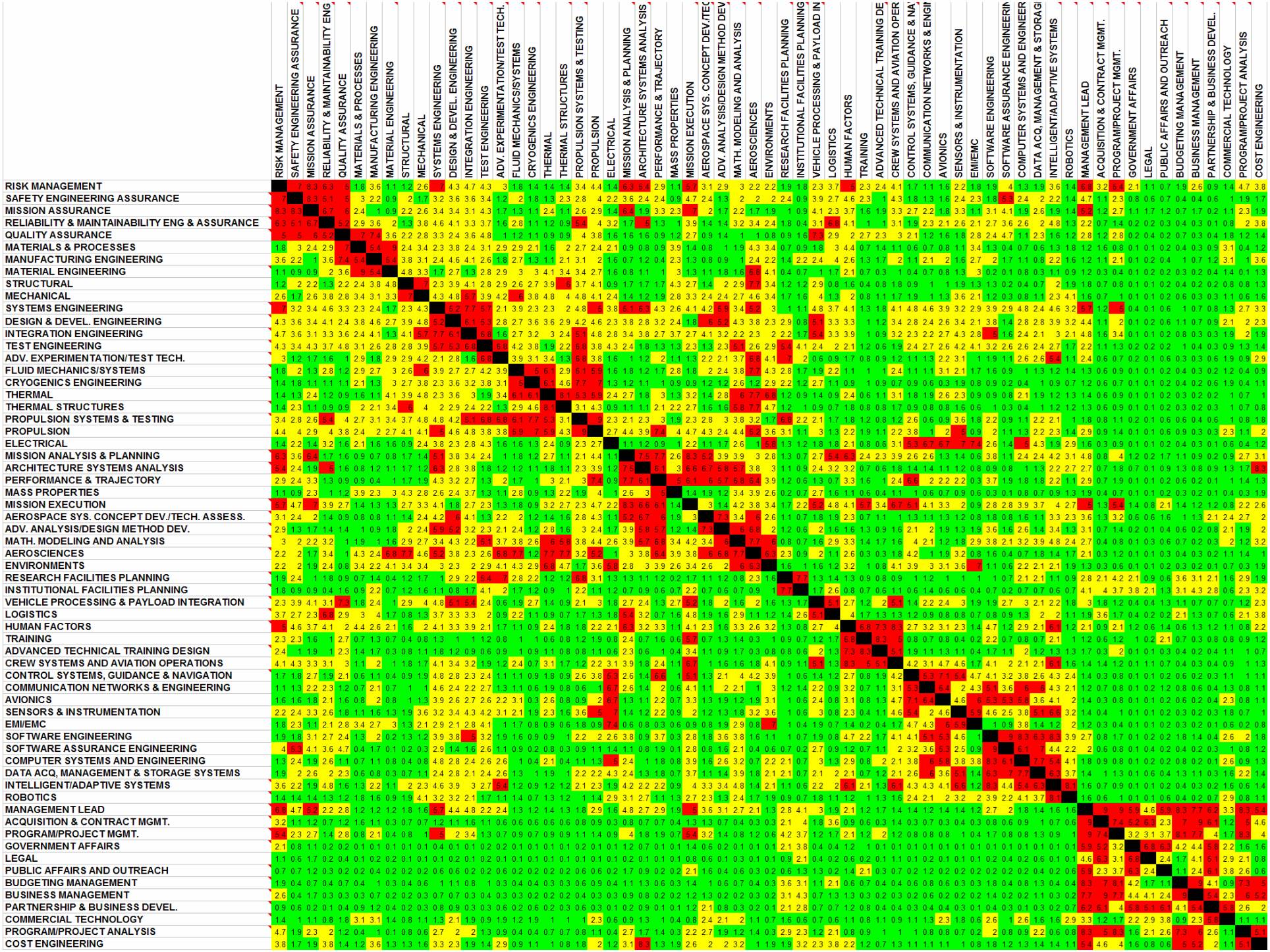
6. Clustering Analysis was then performed.

a. Highest Interactions (red) clustered around the diagonal.

b. Team consensus meetings were held to refine the model.

c. Once consensus was reached, the individual IDTs could then be identified and named.

d. Analysis results were then presented to Constellation Management and Center POCs.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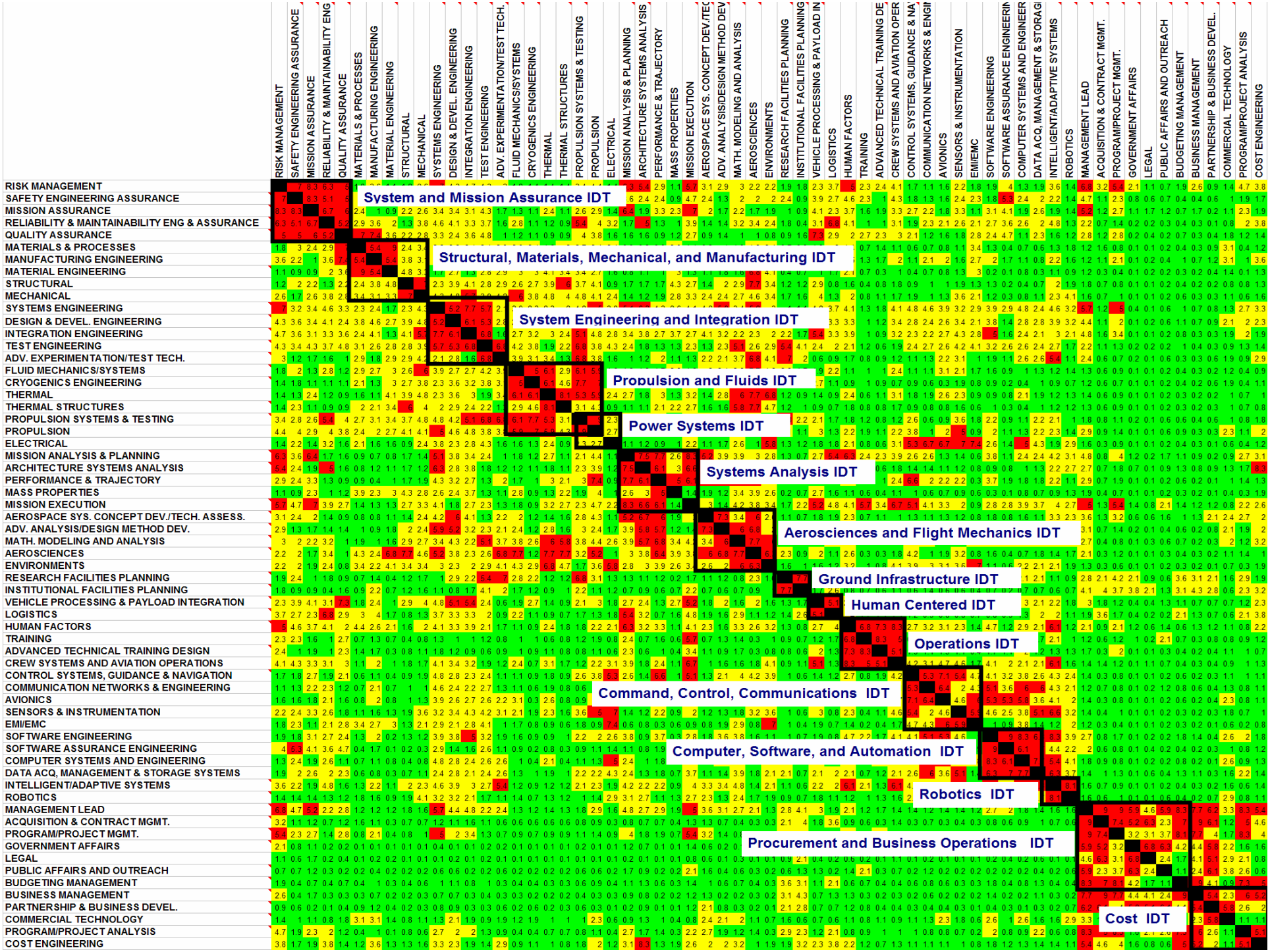
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System Engineering and Integration IDT
Propulsion and Fluids IDT
Power Systems IDT
Systems Analysis IDT
Aerosciences and Flight Mechanics IDT
Ground Infrastructure IDT
Human Centered IDT
Operations IDT
Command, Control, Communications IDT
Computer, Software, and Automation IDT
Robotics IDT
Procurement and Business Operations IDT
Cost IDT

IDT Formulation Conclusion: Success!

- **Constellation management implemented the recommended IDT formulation.**
  - Because of team representation, buy-in from Centers was immediate.
  - Management appreciated that the entire process was traceable.
- **ODT requested to perform additional DSM Analyses.**
  - Langley Research Center reorganization application to determine which branches should be collocated across directorates.